Original Article

Are energy drinks contributing to the obesity epidemic?

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The consumption of energy drinks containing sucrose and caffeine is increasing worldwide. Ten healthy women aged 18 to 22 years and fasted overnight were randomly allocated to a standardised dose of sucrose either as an “energy” drink (containing sucrose and caffeine) or lemonade on the first day and then crossed over to the alternative drink on a second day. For thirty minutes before and thirty minutes after drinking oxygen consumption and carbon dioxide production were measured in the resting subject breath-by-breath by indirect calorimetry and the rates of carbohydrate and fat oxidation calculated. Energy drink consumption apparently caused increased carbohydrate oxidation \((P = 0.004)\) and reduced lipid oxidation \((P = 0.004)\) compared to lemonade. The longer term effects of combined caffeine and sucrose intake, particularly in sedentary individuals, on metabolism and body fatness needs further examination.

Key Words: lipogenesis, caffeine, sucrose, carbonated beverage, fat oxidation, carbohydrate oxidation.

Introduction

The world is experiencing an epidemic of obesity and Type 2 diabetes. This is thought to be due to significant lifestyle changes over the last 30 years which include an increase in the consumption of drinks containing both sucrose and caffeine.¹ Fructose which is produced along with glucose from the breakdown of sucrose has been implicated in weight gain and the insulin resistance syndrome.² Caffeine is recognised as an ergogenic aid³ and a diet high in simple carbohydrates increases fatty acid synthesis⁴ but few studies have examined the effect on substrate metabolism of the ingestion of sucrose with caffeine. Caffeine- and sucrose-containing drinks are marketed as energy boosting and therefore an aid to weight loss. Caffeine alone is unlikely to increase fat oxidation and may increase insulin resistance in skeletal muscle.⁵ New Zealand’s “V” energy drink (Frucor Beverages, Manukau City, New Zealand) contains 28g sucrose and 81mg caffeine per 250-mL can which is similar to the quantities of sucrose in soft drinks and caffeine in a brewed cup of coffee. We report the results of a study investigating the effects of V on fat and carbohydrate oxidation compared to sucrose alone.

Methods

Ten healthy women, (2 Chinese, 4 Filipino, 1 Indian, 3 European) aged 18 to 22 years (BMI 22.3 (3.5) kg/m²) and fasted overnight were randomly allocated to a standardised dose of sucrose (0.4g/kg body weight) either as V energy drink (V group) or lemonade (L group) on the first day and then crossed over to the alternative drink on a second day. Both drinks were reported to have equal carbonation (personal communication) and were opened just prior to consumption. The subjects reclined on a bed supported by cushions. For 30 minutes before and 30 minutes after drinking VO₂ and VCO₂ were continuously measured breath by breath (Vista CPX, Vacumed, Ca) and heart rate was measured every minute by pulse oximetry. Respiratory exchange ratio (RER) was calculated as VCO₂/VO₂. From these data carbohydrate and fat oxidation rates were calculated.⁶ The study was approved by the Auckland University of Technology Ethics Committee. Standard statistical techniques for crossover studies were used to assess treatment effect, period effect and treatment x period interaction by Student t test.⁷

Results

Complete data were collected from all 10 women. In 10 of 10 women the consumption of V caused a progressive increase in the oxidation of carbohydrate and reduction in the oxidation of fat compared with lemonade. Figure 1 shows the aggregate 30-min cumulative data for all women for carbohydrate and fat oxidation for the two beverages. The increase in carbohydrate oxidation rate following V consumption was greater than that observed following lemonade consumption \((P = 0.004, Table 1)\).

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This was accompanied by decreased fat oxidation rate after both drinks. The rate of fat oxidation after V consumption was negative between the 8 and 22 minute time points (and at this time the RER was greater than 1.00) indicating lipogenesis when compared with lemonade consumption ($P = 0.004$). V consumption was also associated with a significant increase in minute volume ($P = 0.014$) and $\text{VCO}_2$ ($P = 0.020$) but no statistically significant change in heart rate, respiration rate or $\text{VO}_2$.

**Discussion**

In this small study of young women we have demonstrated that consumption of a standardised amount of an energy drink containing sucrose and caffeine amounting to 24 g of sucrose and 80 mg of caffeine for a 60 kg body weight increases depth of respiration and increases carbohydrate oxidation but suppresses fat oxidation and could cause lipogenesis. We have only considered one variety of energy drink in this study and the caffeine was derived from both added caffeine (200mg/L) and guarana (120 mg/L).

We are not aware of any human studies that have examined the synergistic effects of sucrose and caffeine or guarana on fat metabolism. A study of men using the hyperinsulinemic-euglycaemic clamp technique to examine glucose disposal in resting humans suggested that caffeine acts as an adenosine receptor antagonist and lowers glucose uptake. They showed that glucose uptake was 24% less and glycogen storage 35% less with caffeine compared to a dextrose placebo. They proposed that skeletal muscle became more resistant to insulin with the administration of caffeine. Our dose of caffeine (1.3 mg/kg body weight) was particularly low compared with other studies of ergogenic effects which range from 2-9

**Table 1.** Crossover trial of effects of V energy drink consumption relative to lemonade on respiratory parameters and substrate oxidation in 10 women.

<table>
<thead>
<tr>
<th>Treatment</th>
<th>$P$</th>
</tr>
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<tbody>
<tr>
<td></td>
<td>Before drink</td>
</tr>
<tr>
<td>Heart rate (beats/min)</td>
<td>V 70.8(2.1)</td>
</tr>
<tr>
<td>L 69.1(2.2)</td>
<td>71.4(2.8)</td>
</tr>
<tr>
<td>Respiratory rate (/min)</td>
<td>V 16.1(0-8)</td>
</tr>
<tr>
<td>L 15.7(1.0)</td>
<td>15.6(1.1)</td>
</tr>
<tr>
<td>VE (L/min)</td>
<td>V 7.2(0-4)</td>
</tr>
<tr>
<td>L 7.2(0.3)</td>
<td>7.9(0-4)</td>
</tr>
<tr>
<td>$\text{VCO}_2$ (mL/min)</td>
<td>V 225(13)</td>
</tr>
<tr>
<td>L 219(7)</td>
<td>252(10)</td>
</tr>
<tr>
<td>$\text{VO}_2$ (mL/min)</td>
<td>V 269(12)</td>
</tr>
<tr>
<td>L 266(8)</td>
<td>291(11)</td>
</tr>
<tr>
<td>CHO oxidation (g/min)</td>
<td>V 0.113(0.024)</td>
</tr>
<tr>
<td>L 0.099(0.013)</td>
<td>0.168(0.022)</td>
</tr>
<tr>
<td>Fat oxidation (g/min)</td>
<td>V 0.044(0.006)</td>
</tr>
<tr>
<td>L 0.047(0.004)</td>
<td>0.034(0.008)</td>
</tr>
</tbody>
</table>

Values are mean(SEM) over 30 minutes of recording. No significant period effect or treatment x period interaction were observed so the data before and after each treatment were pooled. Abbreviations: V, V energy drink consumed; L, lemonade consumed; VE, minute volume; $\text{VCO}_2$, carbon dioxide consumption rate; $\text{VO}_2$, oxygen uptake rate; CHO, carbohydrate.

**Figure 1.** Cumulative carbohydrate and fat oxidation before (x) and after consumption of lemonade (triangles) or V energy drink (circles) in 10 women. Data are mean ± SEM over two minutes of breath by breath recording. Results obtained before lemonade and before V consumption were similar and are combined in the figure.
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Energy drinks are a global phenomenon with increased consumption of sugary and caffeinated beverages. The “energy drinks” contain high levels of caffeine and sugars, which are also rich in calories. The effects of energy drinks on metabolic health, particularly on lipogenesis and insulin resistance, are being studied to determine if they contribute to the obesity epidemic.

References

mg/kg; however our dose is more reflective of the real-life situation. The wide perception that these drinks are designed as energy boosters needs to be tempered by the fact they may also be lipogenic. This may have implications for consumption of food and drink where caffeine and simple sugars are both present. The reported half-life of caffeine in the body is 4-6 hours.³ The longer term effect of combined caffeine and sucrose intake particularly in sedentary individuals on promotion of lipogenesis and insulin resistance in relation to frequency of consumption, needs urgent examination.

Keywords: fat synthesis, caffeine, sucrose, carbonated beverages, fat oxidation, carbohydrate oxidation.

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